Decontamination and Conversion of Nickel Radioactive Scrap Metal

Deactivation & Decommissioning FOCUS AREA

Developer: Manufacturing Sciences Corporation
Contract Number: DE-AC21-93MC30170
Crosscutting Area: N/A

Problem:

The deactivation and decommissioning (D&D) of Department of Energy (DOE) facilities will generate vast quantities of radioactive scrap metal (RSM) from process equipment, utilities, and structures. Nickel makes up about 19 percent of the total expected scrap volume but may carry more than 84 percent of the total value based upon current scrap prices. The nickel has been in intimate contact with uranium compounds and is also contaminated with fission products including technetium-99 (^{99}Tc) and trace amounts of neptunium, plutonium, and americium. The contamination cannot be completely removed by surface decontamination methods. Cost-effective technologies are needed to remove or reduce the contamination in order to permit recycle or reuse of this valuable resource.

Solution:

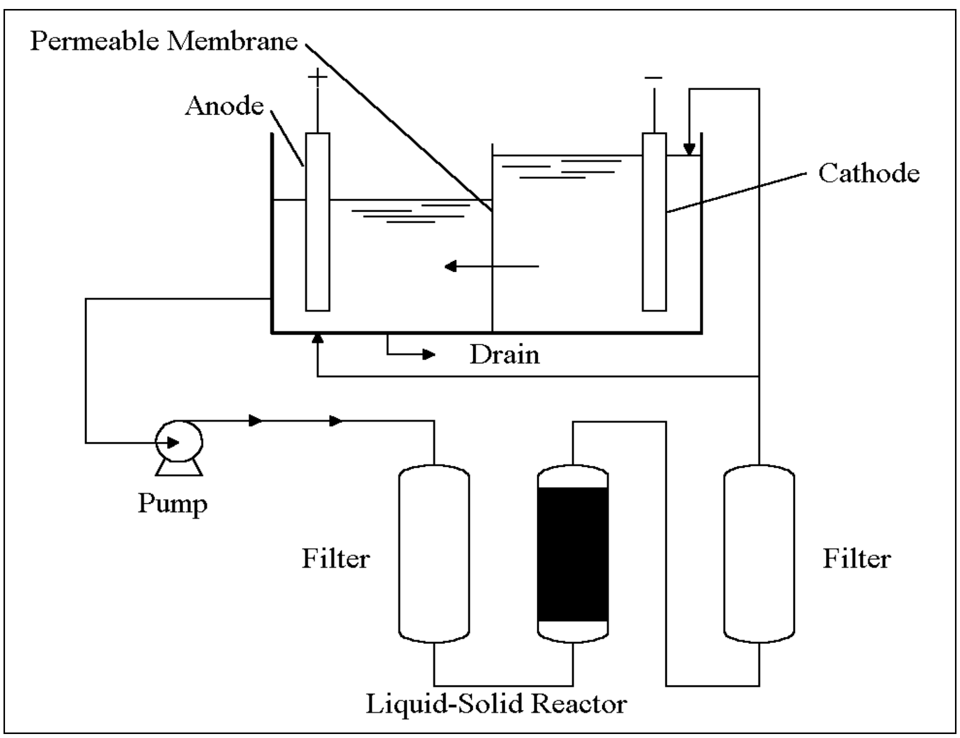
Develop and successfully demonstrate a technically effective and cost-efficient process using electrorefining to remove and/or reduce the radioactive contamination of nickel.

Benefits:

- Economical recovery of a valuable national resource
- Decontamination and recycle to useful new products
- Elimination of an environmental liability
- Application to recycle of metals of all types

Technology:

The electrorefining process consists of a refining cell that is divided into two compartments separated by a permeable membrane. In the anodic compartment, feedstock nickel anodes are dissolved electrolytically in a sulfate-based electrolyte. The electrolyte from the anodic compartment (anolyte) is continuously withdrawn via a pump and circulated through a bed of nickel powder, or some other liquid-solid contactor, where the technetium ^{99}Tc is deposited in its metallic state via the displacement reaction with nickel. The Tc-free, treated anolyte is then filtered and split into two streams. One stream is returned to the anodic chamber, while the second stream is added to the cathodic chamber. The stream flow volumes are adjusted so that the catholyte liquid level is 2 to 6 inches above the anolyte liquid level.



This will insure a continuous flow of electrolyte from the cathodic chamber through the permeable membrane to the anodic chamber via the hydrostatic pressure differential. This flow prevents the diffusion of pertechnetate ions from the anolyte through the membrane into the catolyte. Purified nickel is deposited from the ^{99}Tc-free catolyte onto thin foil "seed" nickel cathodes. The cell operates on a semi-continuous basis, needing to be interrupted only when the cathodes and anodes must be replaced. The electrolyte can be used for extended periods of time, and will only have to be treated or replaced to remove accumulated contaminants, which are present in trace amounts in the feedstock nickel.

While there are currently no criteria for release and unrestricted use of materials that have had radioactive contamination removed or reduced, the proposed International Atomic Energy Agency (IAEA) standard of less than or equal to 1 Becquerel per gram will be used to compare results of this project.

Blending of slightly contaminated nickel with uncontaminated or decontaminated scrap steel may be an effective strategy for economic return of the resource to commerce. The project will use the refined nickel to make stainless steel and high-nickel alloys which will be subjected to rolling, forming, and welding trials.
During the project's first phase, experiments were performed to determine optimum conditions for effective removal of radioactive contaminants. Major accomplishments in Phase II were the successful lab-scale and pilot- scale demonstrations of electrorefining technology to remove ^{99}Tc from diffusion plant nickel. In Phase III, the system will be further optimized and enlarged to a full-scale working cell. A new product made from radioactive scrap metal, the sanitary drum, was launched in Phase II based on a Savannah River Site request. This product barely scratches the surface of the wide range of products fabricated from RSM that could be made available to DOE facilities. Phase III efforts will continue the search to match recycled products to demand.

DOE has awarded a fixed price contract worth $238 million to BFNL, Inc., to decontaminate three huge buildings at the K-25 Site and help prepare the Oak Ridge installation for private use. As part of the agreement, the company will remove equipment and take ownership of 130,000 tons of metals valued at about $50 million. In this contract, Manufacturing Sciences Corporation (MSC) is a teaming partner with BNFL to decontaminate nickel and other metals. The electrorefining technology developed under this contract will be deployed to decontaminate 6,000 tons of nickel alone along with other metals.

Contacts:

MSC is a manufacturer of products from recycled specialty metals, including depleted uranium, beryllium, and radioactively-contaminated scrap metals. For information regarding this project, the contractor contact is:

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DOE's Federal Energy Technology Center supports the Environmental Management - Office of Science and Technology by contracting the research and development of new technologies for waste site characterization and cleanup. For information regarding this project, the DOE contact is:

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